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(54) **SYSTEMS AND METHODS FOR DISPLAYING IMAGES WITH MULTI-RESOLUTION INTEGRATION**

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USPC 345/419
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(57) **ABSTRACT**

A display system is provided for a vehicle. The system includes a first data source configured to provide low resolution terrain data; a second data source configured to provide high resolution terrain data; a processing unit coupled to the first data source and the second data source, the processing unit configured to receive the low resolution terrain data and high resolution terrain data, to integrate the low resolution terrain data and the high resolution terrain data into a common three-dimensional view that includes graphical elements representing both the low and the high resolution terrain data, and to supply display commands associated with the low and the high resolution terrain data; and a display device coupled to the processing unit and configured to receive the display commands and operable to render the common three-dimensional view to thereby allow simultaneous viewing of the low and the high resolution terrain data.

15 Claims, 4 Drawing Sheets
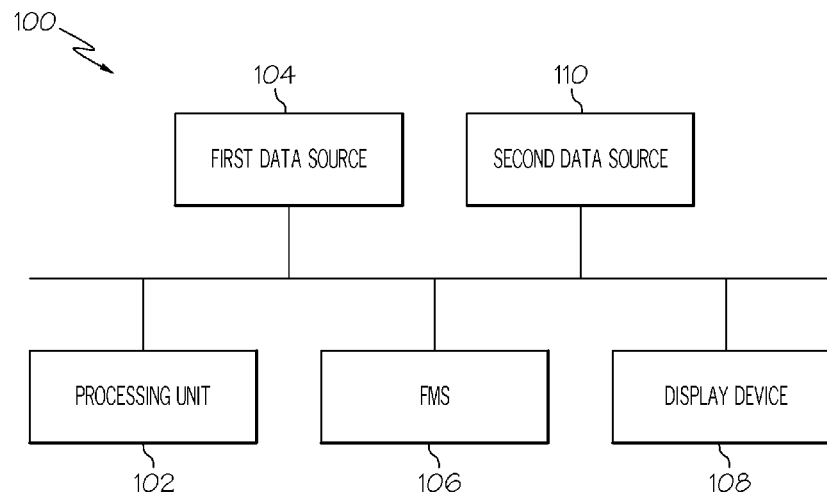
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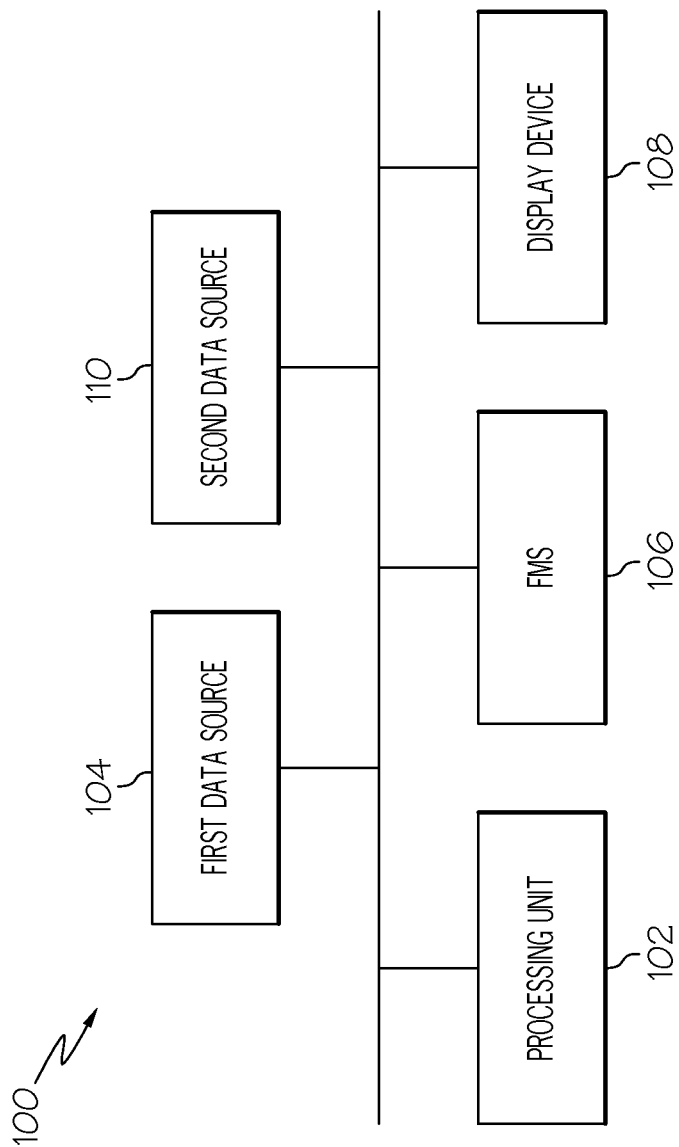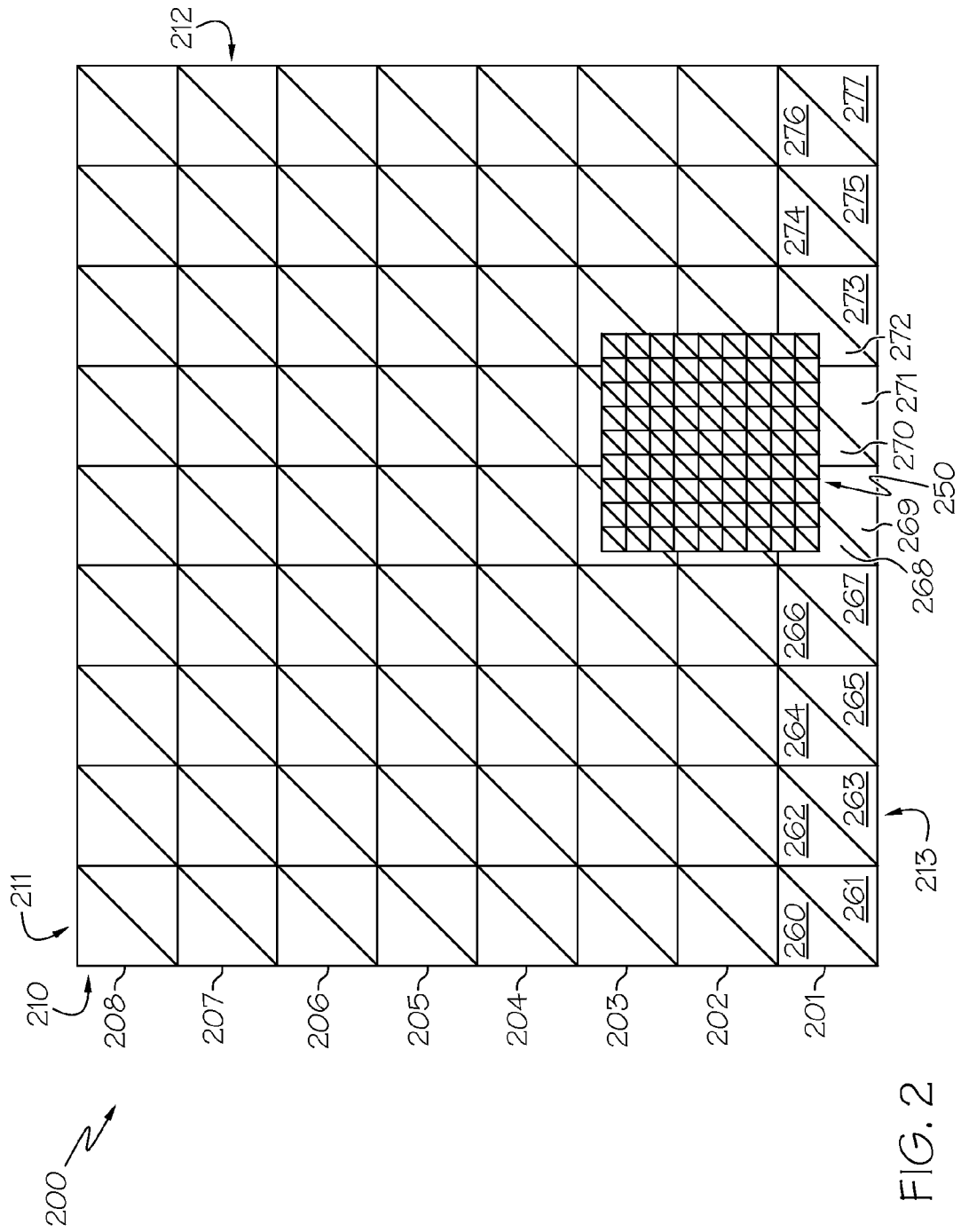EP Exam Report, EP 12 181 923.9 dated Apr. 8, 2013.

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FIG. 1

FIG. 2

_300_

DETERMINE BOUNDARIES OF FIELD OF VIEW (FOV) _305_

DETERMINE BOUNDING BOXES OF HIGH RESOLUTION TERRAIN DATA _310_

_315_ ANY HIGH RESOLUTION TERRAIN DATA WITHIN FOV?

NO → _320_ GENERATE FOV MESH WITH LOW RESOLUTION TERRAIN DATA

GENERATE DISPLAY COMMANDS BASED ON LOW RESOLUTION TERRAIN DATA

_325_

YES

GENERATE FOV MESH WITH HIGH RESOLUTION TERRAIN DATA PATCH _330_

DETERMINE STARTING POINT FOR RENDERING FOV MESH WITH LOW RESOLUTION TERRAIN DATA _335_

FORM LOW RESOLUTION MESH STRIP _340_

_350_ CUT OUT PORTION OF LOW RESOLUTION MESH STRIP INTERSECTED BY HIGH RESOLUTION PATCH

_345_ ANY INTERSECTIONS BETWEEN HIGH RESOLUTION PATCH AND LOW RESOLUTION MESH STRIP?

YES →

STITCH HIGH RESOLUTION PATCH TO LOW RESOLUTION MESH STRIP, BLENDING GEOMETRY TO REMOVE DISCONTINUITIES

_355_

NO

_360_ COMPLETED FOV?

NO

YES

GENERATE DISPLAY COMMANDS BASED ON INTEGRATED DATA _365_
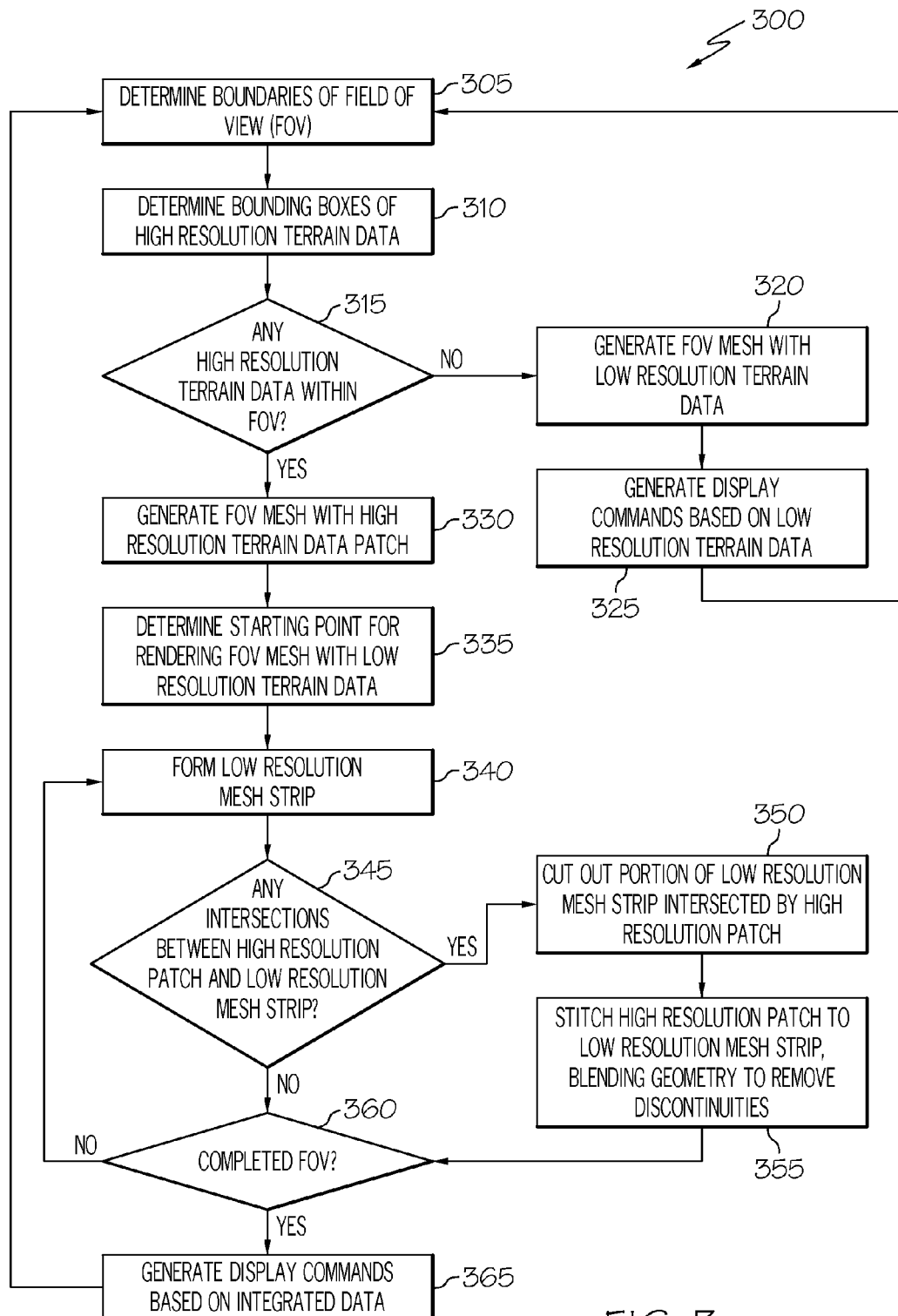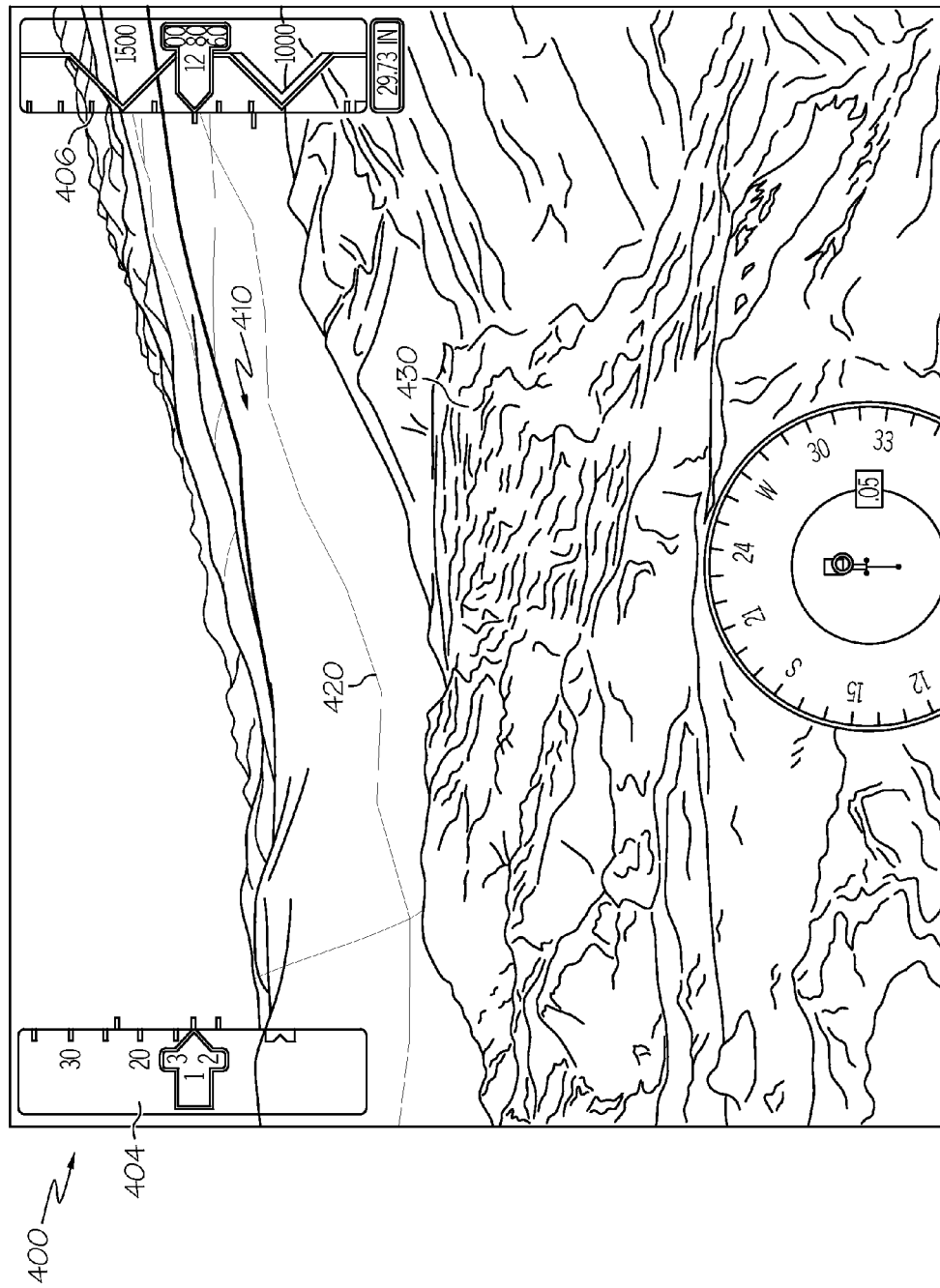
FIG. 3

FIG. 4

SYSTEMS AND METHODS FOR DISPLAYING IMAGES WITH MULTI-RESOLUTION INTEGRATION

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

This invention was made with Government support under W91215-10-C-0003 awarded by USASOC Technology Application Program Office. The Government has certain rights in the invention.

TECHNICAL FIELD

The present invention generally relates to aircraft display systems and methods and, more particularly, to systems and methods that display images representing terrain data.

BACKGROUND

Computer generated aircraft displays have become highly sophisticated and capable of displaying a substantial amount of flight management, navigation, and control information that gives flight crews more effective control of the aircraft and a reduction in workload. In this regard, electronic displays, such as Heads-Up Displays (HUDs) and Heads-Down Displays (HDDs), are used in aircraft as Primary Flight Displays to display important flight management, navigation, and control information to flight crews. For example, the Primary Flight Display can combine critical flight instrumentation (e.g., altitude, attitude, heading, airspeed, vertical speed instruments) and primary engine instrument indicators into a single, readily interpretable display.

Some Primary Flight Displays may provide a 3D, synthetic perspective view of the terrain surrounding the aircraft, including man-made and natural terrain. Examples include Synthetic Vision Systems (SVSs). These images are typically based on pre-loaded and predetermined terrain data from a database or terrain data from a sensor system. Storing and processing large amounts of this terrain data may be difficult, especially at a level of detail desired for a synthetic display.

Accordingly, it is desirable to provide systems and methods with improved rendering of terrain data on a visual display, such as, for example, a Primary Flight Display, similar electronic aircraft displays, and other types of electronic displays. Furthermore, other desirable features and characteristics of the present invention will become apparent from the subsequent detailed description of the invention and the appended claims, taken in conjunction with the accompanying drawings and this background of the invention.

BRIEF SUMMARY

In accordance with an exemplary embodiment, a display system is provided for a vehicle. The display system includes a first data source configured to provide low resolution terrain data; a second data source configured to provide high resolution terrain data; a processing unit coupled to the first data source and the second data source, the processing unit configured to receive the low resolution terrain data and high resolution terrain data, to integrate the low resolution terrain data and the high resolution terrain data into a common three-dimensional view that comprises graphical elements representing both the low resolution terrain data and the high resolution terrain data, and to supply display commands associated with the low resolution terrain data and the high resolution terrain data; and a display device coupled to the pro-

cessing unit and configured to receive the display commands and operable to render the common three-dimensional view to thereby allow simultaneous viewing of the low resolution terrain data and the high resolution terrain data.

In accordance with another exemplary embodiment, a method is provided for displaying multi-resolution terrain data. The method includes receiving low resolution terrain data from a first data source; receiving high resolution terrain data from a second data source; blending the low resolution terrain data and the high resolution terrain data into a field of view (FOV); and producing display signals for the FOV

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will hereinafter be described in conjunction with the following drawing figures, wherein like numerals denote like elements, and wherein:

FIG. 1 is a functional block diagram of an aircraft display system in accordance with an exemplary embodiment;

FIG. 2 is a schematic representation of a visual display with integrated high and low resolution terrain data in accordance with an exemplary embodiment;

FIG. 3 is a flowchart describing a method for displaying images representing integrated high and low resolution terrain data in accordance with an exemplary embodiment; and

FIG. 4 depicts an exemplary image of the visual display rendered by the aircraft display system of FIG. 1 in accordance with an exemplary embodiment.

DETAILED DESCRIPTION

The following detailed description is merely exemplary in nature and is not intended to limit the invention or the application and uses of the invention. Furthermore, there is no intention to be bound by any theory presented in the preceding background or the following detailed description.

Broadly, exemplary embodiments described herein provide visual display systems and methods for aircraft. More specifically, the visual display systems and methods display images of terrain data integrated from a first data source with low resolution terrain data and a second data source with high resolution terrain data.

FIG. 1 depicts a block diagram of an exemplary aircraft visual display system 100 for displaying images with integrated high resolution terrain data and low resolution terrain data. In the exemplary embodiment shown, the system 100 includes a processing unit 102, a first data source 104, a flight management system 106, a display device 108, and a second data source 110. Although the system 100 appears in FIG. 1 to be arranged as an integrated system, the system 100 is not so limited and can also include an arrangement whereby one or more of the processing unit 102, the first data source 104, the flight management system 106, the display device 108, and the second data source 110 are separate components or subcomponents of another system located either onboard or external to an aircraft. Also, for example, the system 100 can be arranged as an integrated system (e.g., aircraft display system, Primary Flight Display system, a Head Up Display with SVS or EVS as an overlay (or underlay), a "near to eye display" system, or a head mounted display system, etc.) or a subsystem of a more comprehensive aircraft system (e.g., flight management system, navigation and control system, target aiming and control system, collision alert and/or avoidance system, weather avoidance system, etc.). The system 100 can be utilized in an aircraft, such as a helicopter, airplane, or unmanned vehicle. Moreover, exemplary embodiments of the system 100 can also be utilized in spacecraft,

ships, submarines, fixed wing and rotor aircraft, such as heli-copters, as well as other types of vehicles. For simplicity, embodiments are described below with reference to "air-craft."

The processing unit **102** can be a computer processor asso-ciated with a Primary Flight Display. Generally, the process-ing unit **102** receives and/or retrieves flight management information (e.g., from the flight management system **106**) and landing, target and/or terrain information (e.g., from first data source **104** or second data source **110**). The processing unit **102** generates display control signals for flight manage-ment information, which includes navigation and control symbology such as a zero pitch reference line, heading indi-cators, tapes for airspeed and altitude, flight path information, RNP information, and any other information desired by a flight crew. As discussed in further detail below, the process-ing unit **102** additionally receives and integrates terrain data from the first data source **104** and second data source **110**, and generates display control signals based on the integrated ter-rain data. The processing unit **102** then sends the generated display control signals to a display device (e.g., the display device **108**). More specific functions of the processing unit **102** will be discussed below.

The first data source **104** and the second data source **110** are coupled to the processing unit **102** and may be any suitable type of data source and may be the same or different types of data source. As described below, the first data source **104** may include low resolution terrain data, and the second data source **110** may include high resolution terrain data. The low resolution terrain data and the high resolution terrain data may be stored, for example, according to latitude and longi-tude coordinates. In one exemplary embodiment, the first and second data sources **104** and **110** are disparate data sources.

The first and second data sources **104** and **110** each include regularly spaced elevation values, not necessarily geometri-cally or linearly spaced but often regularly spaced in degree space. As suggested by the labels, high resolution data has a higher resolution than the low resolution data. For example, in one exemplary embodiment, low resolution data may include elevation or height field values with post spacings of 3 to 6 arc seconds (90 to 185 meters, respectively), whereas high resolution elevation or height field data may have post spacings of 1 meter or less (for example, BuckEye data) to result in a significant difference in resolution. In one exem-plary embodiment, the low resolution data and high resolu-tion data may have spacing differences on the order of 1 to 2 orders of magnitude (e.g., 10× or 100× differences in spac-ing). Generally, high resolution data and low resolution data refers to lateral spacing. In exemplary embodiments, the high resolution terrain data and low resolution terrain data may be related to one another by a non-integer relationship or an integer relationship. In some embodiments, the high resolu-tion terrain data and low resolution terrain data may have no predetermined relationship other than the differences in reso-lution between the two data sources **104** and **110**.

In one exemplary embodiment, the first data source **104** and/or the second data source **110** may be a database with stored data. Such a database may be a memory device (e.g., non-volatile memory, disk, drive, tape, optical storage device, mass storage device, etc.) that can store digital landing, way-point, and target location as either absolute coordinate data or as a function of an aircraft's position. The database can addi-tionally include other types of navigation information, such as information used to calculate flight path and determine RNP information. The database can also include, for example, a terrain database, which includes the locations and elevations of natural and man-made terrain. The terrain can

include obstacles, such as buildings and vehicles. Obstacle data can be stored together with terrain or in a separate obstacle only database. The geographic locations and height of the obstacles for typical avionics applications can be obtained through survey or through various reporting ser-vices.

As another example, the first data source **104** and/or second data source **110** may include any suitable sensor for detecting terrain and providing data to the processing unit **102** based on the detected terrain. Such a sensor system may include sen-sors such as radar or forward-looking infrared (FLIR). Other types of imaging sensors may include types such as visible light, millimeter-wave radar, X-band (weather) radar, etc. In one embodiment, the sensor system is a stand-alone system, although in other embodiments, the sensor system can be used to completely or partially verify database. The sensor collected data, after additional verifications, may be later inserted into such databases for future uses.

The flight management system **106** is coupled to process-ing unit **102**, and can provide navigation data associated with the aircraft's current position and flight direction (e.g., head-ing, course, track, etc.) to the processing unit **102**. The navi-gation data provided to the processing unit **102** can also include information about the aircraft's airspeed, altitude, pitch, and other important flight information. In exemplary embodiments, the flight management system **106** can include any suitable position and direction determination devices that are capable of providing the processing unit **102** with at least an aircraft's current position (e.g., in latitudinal and longitu-dinal form), the real-time direction (heading, course, track, etc.) of the aircraft in its flight path, the waypoints along the flight path, and other important flight information (e.g., air-speed, altitude, attitude, etc.). Such information can be pro-vided to the processing unit **102** by, for example, an Inertial Reference System (IRS), Air-data Heading Reference Sys-tem (AHRS), and/or a global positioning system (GPS).

The system **100** also includes the display device **108** coupled to the processing unit **102**. The display device **108** may include any device or apparatus suitable for displaying various types of computer generated symbols and informa-tion representing at least pitch, heading, flight path, airspeed, altitude, landing information, waypoints, targets, obstacle, terrain, and RNP data in an integrated, multi-color or mono-chrome form. Using data retrieved (or received) from the flight management system **106** and/or data sources **104** and **110**, the processing unit **102** executes one or more algorithms (e.g., implemented in software) for determining the position of the various types of desired information on the display device **108**. The processing unit **102** then generates display control signals representing this data, and sends display con-trol signals to the display device **108**. The display device **108** and/or processing unit **102** may include a graphics display generator for generating the appropriate graphical elements on the screen of the display device **108**, as discussed in greater detail below. In this embodiment, the display device **108** is an aircraft cockpit, multi-color display (e.g., a Primary Flight Display).

Although a cockpit display screen may be used to display the above-described flight information symbols and data, any suitable type of display medium capable of visually present-ing multi-colored or monochrome flight information for a pilot or other flight crew member can be provided, such as, for example, various CRT and flat-panel display systems (e.g., CRT displays, LCDs, OLED displays, plasma displays, pro-jection displays, HDDs, HUDs, etc.).

FIG. **2** is a schematic representation of a visual display **200** of integrated high and low resolution terrain data. The sche-

matic representation of the visual display **200** of FIG. **2** will be described briefly prior to a more detailed description of the method **300** for rendering the display **200**. In one exemplary embodiment, the visual display **200** is rendered with a series of "mesh strips," each with a number of triangles or polygons that collectively form the terrain and other flight information formed on the display device **108**. The size of the triangles generally corresponds to the resolution of the respective portion of the visual display **200**. In the representation of visual display **200** of FIG. **2**, the visual display **200** includes a number of low resolution strips **201-208** that may be sequentially formed to render the larger field of view (FOV) (or view frustum), defined by boundaries **210-213**. As described above, the strips (e.g., strip **201**) may be formed by triangles or polygons (e.g., triangles **260-277**). As described in greater detail below, one or more portions of the visual display **200** may be formed with a high resolution patch **250** that replaces corresponding portions of the low resolution mesh (e.g., portions of strips **201-203**). Additional details about the visual display **200** will be described with reference to the method **300** of FIG. **3**, which describes a method for rendering the visual display **200** with integrated multi-resolution terrain data, such as the visual display **200** of FIG. **2** with the system **100** of FIG. **1**.

In one embodiment, the method **300** is used for displaying terrain data in 3D, synthetic view for a Primary Flight Display of an aircraft, such as for example, the system **100** discussed above. As such, the method **300** of FIG. **3** will be described with reference to the system **100** of FIG. **1** and with reference the schematic representation of a visual display **200** of FIG. **2**.

In a first step **305** of the method **300** of FIG. **3**, the processing unit **102** determines the boundaries of the field of view (FOV), e.g., the terrain that the pilot or operator is to view from the aircraft. As described above, in a Primary Flight Display, the FOV is the synthetic terrain that surrounds the aircraft as viewed from the cockpit or other vantage point. The boundaries of the FOV may be expressed as latitude/longitude data and transformed into a "real-world" coordinate system relative to the aircraft or an xyz-coordinate system of the display device **108**. In the schematic representation of FIG. **2**, the boundaries **210-213** of the FOV correspond to the edges of the visual display **200**.

In a second step **310**, the processing unit **102** determines bounding boxes associated with the high resolution terrain data of the second data source **110**, e.g., the boundaries of high resolution terrain data available to the system **100**. In most exemplary embodiments, the high resolution terrain data of the second data source **110** is limited to more important terrain data, such as static target locations, rendezvous positions, landing areas, the terrain along a planned flight path, or generally "points of interest," because of processing and storage capacity limitations. The bounding boxes of high resolution terrain data correspond to the geographical extent of the data, e.g., latitude/longitude data and/or extent (width and length) information. The bounding boxes may be a single patch of high resolution terrain data and/or a contiguous patch of sub-patches or noncontiguous patches of high resolution terrain data.

In a third step **315**, the processing unit **102** compares the bounding boxes of the high resolution terrain data from the second data source **110** to the boundaries of the FOV, and the processing unit **102** determines if any portion of the bounding boxes of high resolution terrain data are within the FOV. If the bounding boxes of high resolution terrain data are not located in the FOV, the method **300** proceeds to step **320**. As such, referring to FIG. **2**, the processing unit **102** evaluates the bounding boxes of high resolution patches to determine if any

patch falls within the boundaries **210-213** of the FOV. In the depicted example of FIG. **2**, the high resolution patch **250** is one such patch that falls within the boundaries **210-213**.

If, however, it is determined that the bounding boxes of the high resolution terrain data is not within the FOV, the method **300** proceeds to step **320**. In step **320**, the processing unit **102** generates a FOV mesh with low resolution terrain data from the first data source **104**. As described above, the low resolution terrain data may be stored according to latitude/longitude and transformed according to the FOV. In the example of FIG. **2**, the FOV mesh would include the strips **201-208** without any high resolution patch (e.g., without high resolution patch **250**). In step **325**, the processing unit **102** generates display commands based on the FOV mesh of low resolution terrain data for display on the display device **108**.

Returning to step **315**, if the processing unit **102** determines that the bounding boxes of high resolution terrain data are located within the FOV, in step **330**, the processing unit **102** generates a FOV mesh for such high resolution terrain data, such as the high resolution patch **250** of FIG. **2**.

In step **335**, the processing unit **102** determines a starting point for rendering a FOV mesh with the low resolution terrain data. The starting point typically refers to an outer extent or corner of the FOV from which a mesh of the entire FOV may be constructed. For example, in FIG. **2**, an exemplary starting point **215** may be a lower corner of the boundaries **210-213**.

In step **340**, the processing unit **102** forms a low resolution mesh strip from the low resolution terrain data of the first data source **104**. Typically, the first FOV mesh strip is formed from the starting point of step **335**. As shown in FIG. **2**, in an initial iteration of step **340**, the first low resolution mesh strip **201** is formed, and in subsequent iterations discussed below, subsequent low resolution mesh strips **202-208** may be formed.

In step **345**, the processing unit **102** determines if there are any intersections between the current low resolution mesh strip and the high resolution patch. As an example, in FIG. **2**, a portion (e.g., triangles **268-272**) of the first low resolution mesh strip **201** intersects the high resolution patch **250**.

If there are intersections between the low resolution mesh strip and the high resolution patch, in step **350**, the processing unit **102** removes the portion of the low resolution mesh strip that intersects the high resolution patch. Referring to the example in FIG. **2**, if the first low resolution mesh strip **201** is the current low resolution mesh strip, triangles **268-272** are removed.

In step **355**, a portion of the high resolution terrain patch replaces the corresponding portion of low resolution mesh strip removed in step **350**. Continuing the example of FIG. **2** in which the first low resolution mesh strip **201** is the current strip, triangles **268-272** are replaced by corresponding portions of the high resolution patch **250**.

After step **355**, the method **300** proceeds to step **360**. Similarly, in step **345**, if there are no intersections between the current low resolution mesh strip and the high resolution patch, the method **300** proceeds to step **360**. In step **360**, the processing unit **102** determines if the current low resolution mesh strip completes the FOV. For example, in FIG. **2**, this does not occur until formation of low resolution mesh strip **208**.

If the FOV is not complete, the method **300** proceeds to step **340** in which a subsequent low resolution mesh strip is formed adjacent to the previous low resolution mesh strip. Continuing the example above with FIG. **2**, in step **340**, the second low resolution mesh strip **202** is formed after an iteration with the first low resolution mesh strip **201**. In steps **345**, **350**, **355**, and **360**, the processing unit **102** continues to

determine intersections between the high resolution patch (or patches), removing portions of the low resolution mesh strips, replacing the removed portions of the low resolution mesh strips with corresponding portions of the high resolution patch, determining if the FOV is completed, and if not, repeating with a subsequent low resolution mesh strip. In FIG. 2, these steps result in the formation of low resolution mesh strips 201-208, and replacing portions of those mesh strips 201-208, if intersected, with portions of the high resolution patch 250, until the boundaries 210-213 of the visual display 200 is completed.

In step 365, the processing unit 102 generates display signals based on integrated low resolution and high resolution data in the FOV according to steps 305-360 and provides the display signals to the display device 108. The method 300 is repeated for each processing cycle of the system 100 to produce a continuously changing FOV image for the pilot.

An exemplary visual display 400 is shown in FIG. 4. The visual display 400 is an exemplary visual display that may be rendered, for example, by the aircraft display system 100 of FIG. 1 and the method 300 of FIG. 3.

The visual display 400 shows, among other things, computer generated symbols and graphical elements representing an airspeed scale or tape 404, an altitude scale or tape 406, and terrain (e.g., identified generally as element 410). Other types of navigation and control symbology or graphical elements, such as a zero-pitch reference line, landing point, and the like may be provided, as necessary or desired. Although the visual display 400 is shown as an egocentric, first-person frame of reference, the visual display 400 can be a secondary, wingman, exocentric, and/or plan or perspective view that enables a viewer to view the aircraft, as well as zoom in and out, including an unmanned vehicle and/or spacecraft. Although the visual display 400 is generally associated with a Primary Flight Display, the display can also be utilized on a multifunction display, Head Up Display, and/or a head mounted display.

In this embodiment, the terrain 410 is rendered as a three-dimensional, perspective view. The terrain 410 can include any representation of the environment surrounding the aircraft, including flattened terrain. Additionally, the terrain 410 can include a virtual plane selected by a pilot at certain elevation relative to the aircraft and is rendered at that elevation.

In addition, and as will now be described in more detail, the visual display 400 may selectively render symbology forming part of the terrain 410 that represents low resolution terrain data from the first data source 104 and that represents high resolution terrain data from the second data source 110. One exemplary method 300 is described above in reference to FIG. 3 to illustrate how the low resolution terrain data from the first data source 104 and high resolution terrain data from the second data source 110 are blended and displayed.

As shown in FIG. 4, the first portion 420 of the terrain 410 corresponds to the low resolution terrain data of the first data source 104, and the second portion 430 of the terrain 310 corresponds to the high resolution terrain data. The high resolution terrain data of the second portion 430 is much more detailed and textured as compared to the low resolution terrain data of the first portion 420. As described above, the system 100 cuts or otherwise removes the low resolution terrain data and splices or patches the high resolution terrain data to provide the second portion 430 within the first portion 420. This embodiment may be in contrast to a system that down-samples resolutions from a single source of data.

Typically, the boundary between the portions 420 and 430 is evident from the difference in detail and no further marking

of the boundary is necessary. However, in other embodiments, the boundary may be emphasized to the viewer.

Accordingly, systems and methods for combining high resolution terrain data and low resolution terrain data are provided. The systems and methods provide a display in which places of interest are shown in more detail with the high resolution terrain data while the other areas of the display are rendered with low resolution terrain data. Such a display provides increased situational awareness while enabling efficient processing and storage of terrain data.

While at least one exemplary embodiment has been presented in the foregoing detailed description of the invention, it should be appreciated that a vast number of variations exist. It should also be appreciated that the exemplary embodiment or exemplary embodiments are only examples, and are not intended to limit the scope, applicability, or configuration of the invention in any way. Rather, the foregoing detailed description will provide those skilled in the art with a convenient road map for implementing an exemplary embodiment of the invention. It being understood that various changes may be made in the function and arrangement of elements described in an exemplary embodiment without departing from the scope of the invention as set forth in the appended claims.

What is claimed is:

1. A display system for a vehicle, comprising:
a first data source configured to provide low resolution terrain 3D geometry data;
a second data source configured to provide high resolution terrain 3D geometry data;
a processing unit coupled to the first data source and the second data source, the processing unit configured to receive the low resolution terrain 3D geometry data and high resolution terrain 3D geometry data, to integrate the low resolution terrain 3D geometry data and the high resolution terrain 3D geometry data into a common three-dimensional view that comprises graphical elements representing both the low resolution terrain 3D geometry data and the high resolution terrain 3D geometry data by forming at least one low resolution mesh strip of the low resolution terrain 3D geometry data corresponding to a FOV, identifying any intersections of a high resolution patch of the high resolution terrain 3D geometry data within the FOV and the at least one low resolution mesh strip, removing a portion of the at least one low resolution mesh strip intersected by the high resolution patch, patching the high resolution patch into the removed portion of the at least one low resolution mesh strip, and blending a boundary between the low resolution terrain 3D geometry data and the high resolution terrain 3D geometry data, and to supply display commands associated with the low resolution terrain 3D geometry data and the high resolution terrain data; and
a display device coupled to the processing unit and configured to receive the display commands and operable to render the common three-dimensional view to thereby allow simultaneous viewing of the low resolution terrain 3D geometry data and the high resolution terrain 3D geometry data.

2. The display system of claim 1, wherein the first data source and the second data source are disparate data sources.

3. The display system of claim 1, wherein the high resolution terrain 3D geometry data of the second data source corresponds to a point of interest.

4. The display system of claim 1, wherein the first data source and the second data source are both databases.

5. The display system of claim 1, wherein the first data source and the second data source are different kinds of data sources.

6. The display system of claim 1, wherein the display device is a Primary Flight Display (PFD) or a Multi-Function Display (MFD).

7. The display system of claim 1, wherein the high resolution terrain 3D geometry data from the first data source has a first resolution relative to lateral spacing and the low resolution terrain 3D geometry data from the second data source has a second resolution relative to lateral spacing, the first resolution being at least an order of magnitude greater than the second resolution.

8. The display system of claim 1,
wherein the high resolution terrain 3D geometry data from the first data source includes elevation values with post spacings of 1 meter or less, and
wherein the low resolution terrain 3D geometry data from the second data source includes elevation values with post spacings of approximately 90 to 185 meters.

9. The display system of claim 1,
wherein, for a first latitude, longitude, and elevation coordinate,
the high resolution terrain 3D geometry data from the first data source includes the first latitude, longitude, and elevation coordinate at a first resolution,
the low resolution terrain 3D geometry data from the second data source includes the first latitude, longitude, and elevation coordinate at a second resolution, lower than the first resolution.

10. A method for displaying multi-resolution terrain data on an aircraft display, the method comprising:
determining boundaries of a field of view (FOV) of a user of the aircraft display;
storing low resolution terrain 3D geometry data in a first data source;
storing high resolution terrain 3D geometry data in a second data source, the high resolution terrain 3D geometry data at least partially grouped according a plurality of bounding boxes;
comparing the boundaries of the FOV to the bounding boxes of the high resolution terrain geometry data;
determining if a first portion of at least one of the bounding boxes is within the boundaries of the FOV;
if the first portion of the at least one of the bounding boxes is within the boundaries of the FOV
generating a high resolution patch for the high resolution terrain 3D geometry data within at least the first portion of the at least one of the bounding boxes within the boundaries of the FOV:
forming at least one low resolution mesh strip of low resolution terrain 3D geometry data corresponding to the FOV;

identifying any intersections between the high resolution patch and the at least one low resolution mesh strip;
removing a portion of the at least one low resolution mesh strip intersected by the high resolution patch;
patching the high resolution patch into the removed portion of the at least one low resolution mesh strip; blending the intersections of the high resolution patch and the at least one low resolution mesh strip to generate an integrated FOV image on the aircraft display; and
if the first portion of the at least one of the bounding boxes is outside of the boundaries of the FOV, generating a low resolution FOV image on the aircraft display.

11. The method of claim 10, wherein each of the integrated FOV image and the low resolution FOV image is a continuous, three dimensional perspective view.

12. The method of claim 10, wherein the high resolution terrain 3D geometry data has a resolution at least 10 times greater than the low resolution terrain 3D geometry data with respect to lateral spacing.

13. The method of claim 10, wherein the high resolution terrain 3D geometry data has a resolution with a non-integer relationship relative to the low resolution terrain 3D geometry data.

14. The method of claim 10, wherein the blending and generating steps include rendering the integrated FOV image and the low resolution FOV image on a Primary Flight Display (PFD) or a Multi-Function Display (MFD).

15. A method for displaying multi-resolution terrain data in a field of view (FOV), the method comprising:
receiving low resolution terrain 3D geometry data from a first data source;
forming a low resolution mesh from the low resolution terrain 3D geometry data corresponding to the FOV;
reviewing high resolution terrain 3D geometry data from a second data source for high resolution terrain data associated with the FOV;
generating a high resolution patch from the high resolution terrain 3D geometry data corresponding to the FOV;
identifying any intersections between the high resolution patch and the low resolution mesh;
removing a portion of the low resolution mesh intersected by the high resolution patch;
patching the removed portion of the low resolution mesh with at least a portion of the high resolution patch;
blending the resulting low resolution terrain 3D geometry data and the high resolution terrain 3D geometry data into a continuous, three-dimensional perspective view of integrated high resolution terrain 3D geometry data and low resolution terrain 3D geometry data, the high resolution terrain 3D geometry data having a resolution higher than the low resolution terrain 3D geometry data and having a non-integer relationship; and
producing display signals for the FOV.

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